



British Thoracic Society community-acquired pneumonia care bundle: results of a national implementation project

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ABSTRACT

In 2013, 16 UK hospital trusts participated in a quality improvement programme involving implementation of a community-acquired pneumonia (CAP) care bundle.

High-level data were collected on 14 962 patients admitted with CAP; bundle implementation increased from 1% in October 2012 to 20% by September 2013. Analysis of patient-level data on 2118 adults (median age 75.3 years) found that in the bundle-implementation group, significantly more patients received antibiotics within 4 h of admission (adjusted OR 1.52, 95% CI 1.08 to 2.14, $p=0.016$) and 30-day inpatient mortality was lower (8.8% vs 13.6%; adjusted OR 0.59, 95% CI 0.37 to 0.95, $p=0.03$).

BACKGROUND

Adults admitted to hospital with community-acquired pneumonia (CAP) continue to suffer high morbidity and mortality; the average length of hospital stay in the UK is 6 days, and mortality at 30 days is approximately 18%.¹ In 2012, a strategic partnership was formed between the British Thoracic Society (BTS) and NHS Improvement (NHSI) (under the auspices of the Department of Health Respiratory Programme) to design a pilot project encompassing education in service improvement methodology and the use of care bundles as a vehicle to deliver better care. CAP was chosen for this project as some evidence already existed, supporting measurable improvements in care following implementation of pneumonia bundles within pay-for-performance programmes.² This report describes the results of a study evaluating the implementation of the BTS CAP care bundle across 16 UK trusts.

METHODS

Study population

Beginning in October 2012, a total of 16 trusts were invited to participate in the BTS CAP care bundle project for a period of 13 months. Sites were requested to include immunocompetent adults (≥ 16 years) hospitalised with CAP. Inclusion criteria were age over 16 years with symptoms suggestive of lower respiratory tract infection, radiologically confirmed CAP and treatment for CAP by the admitting clinical team. Adults previously discharged from hospital within 10 days of admission were excluded from the project. The

four elements of the CAP care bundle (acronym COST) consisted of:

1. chest X-ray obtained within 4 h of hospital admission in all adults with suspected CAP
2. oxygen assessment and prescription in keeping with BTS oxygen guideline
3. severity assessment, supported by the CURB-65 score
4. timely and targeted antibiotics given according to CAP severity within 4 h of admission.³

Bundle implementation was at the discretion of the admitting clinical team.

High-level outcome data pertaining to the total number of CAP admissions to the trust, total number of patients in whom the bundle was implemented, in-hospital mortality, total bed days, length of stay (LOS) and pneumonia readmission rate at 28 days were collected for all patients with an International Classification of Diseases 10 diagnostic code of J12–18 (including all subcategories except 18.0) as the primary diagnosis. Individual patient-level data were collected using standardised forms, and entered via the BTS audit website. Implementation of the care bundle was approved by the BTS Professional and Operational Standards Committee; as a quality improvement project, individual patient consent was not required.

Definitions

Patients were deemed to have received the bundle if delivery of the bundle to the patient was recorded locally; the mode of delivery was determined locally (please see the BTS website for more details).³ Delivery of the bundle did not necessarily mean all elements of the bundle were completed. The primary outcome measures were: (1) time to first chest X-ray ≤ 4 h from admission, (2) time to first antibiotic dose ≤ 4 h from admission, (3) adherence to BTS CAP Guidelines-recommended antibiotic choice (low-severity CAP: monotherapy with a narrow-spectrum beta-lactam (amoxicillin) or tetracycline or macrolide; moderate-severity CAP: combination narrow-spectrum beta-lactam (amoxicillin) plus macrolide or tetracycline monotherapy or quinolone monotherapy; high-severity CAP: combination beta-lactamase stable beta-lactam plus macrolide or narrow-spectrum beta-lactam plus quinolone therapy), (4) adherence to BTS CAP Guidelines-recommended antibiotic route of administration (low-severity and moderate-severity CAP: oral therapy; high-severity CAP: intravenous



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therapy) and (5) assessment of oxygenation status. Secondary outcome measures were 30-day inpatient (30-day IP) mortality and LOS.

Data analysis

Statistical analysis was performed using SPSS V22.0. Comparisons were made between adults receiving and not receiving the bundle. Pearson's χ^2 test was used to compare categorical variables and the Mann-Whitney U test to compare continuous variables that were not normally distributed.

All primary outcome measures were adjusted for disease severity (based on the CURB-65 score) using a logistical regression model, except for antibiotic choice and antibiotic route, as these two outcomes were already stratified according to disease severity. Of the secondary outcome measures, 30-day IP mortality was adjusted for disease severity using a similar model.

RESULTS

Over the 13-month period of the project (October 2012–October 2013), based on high-level data, a total of 14 962 patients were admitted with CAP to the 16 participating trusts (see online supplementary table S1). Implementation of the CAP care bundle was progressive over time; from 1% of admitted patients in October 2012 to 20% by September 2013 (see online supplementary figure S1).

Individual patient-level data from 2563 adults were submitted by the 16 participating trusts (see online supplementary table S2). Median age of the cohort was 75.3 years (IQR 59.4–85.1), and 1319 (51.5%) were male. Disease severity according to the CURB-65 score was low, moderate and high in 1154 (45.0%), 706 (27.5%) and 703 (27.4%) adults, accordingly. Adults for

whom data regarding bundle delivery were unavailable (n=132) and adults without radiological evidence of pneumonia (n=313) were excluded from subsequent analyses. Of the remaining 2118 adults, the bundle was delivered in 250 (11.8%). There were no statistically significant differences between 'bundle' versus 'no bundle' groups with regard to area of first assessment, baseline characteristics or disease severity (table 1).

Primary outcome measures

Data regarding timing of antibiotic administration, timing of chest X-ray and oxygenation assessment were unavailable for 370 adults, leaving 1748 adults for these analyses. Time to chest X-ray ≤ 4 h and oxygenation assessment were not associated with bundle delivery (table 1). Time to first antibiotic ≤ 4 h was significantly better in the bundle group (adjusted OR 1.52, 95% CI 1.08 to 2.14, $p=0.016$).

Data regarding type and route of antibiotic administered were unavailable for a further 55 adults. Guideline adherence according to antibiotic route and type did not differ significantly between 'bundle' versus 'no bundle' groups (antibiotic route: 63/143 (44.1%) vs 573/1550 (37.0%), OR 1.34, 95% CI 0.95 to 1.90, $p=0.094$; antibiotic type: 42/143 (29.4%) vs 387/1550 (25.0%), OR 1.25, 95% CI 0.86 to 1.82, $p=0.247$).

Secondary outcome measures

Of the 2118 adults, mortality data were absent for six adults. Adjusted 30-day IP mortality was significantly lower in the 'bundle' compared with 'no bundle' group (30-day IP mortality 22/250 (8.8%) vs 253/1862 (13.6%), respectively; adjusted OR 0.59, 95% CI 0.37 to 0.95, $p=0.030$). Unadjusted LOS

Table 1 Baseline features and outcome measures according to CAP bundle delivery

Baseline features	CAP bundle (n=250)	No-CAP bundle (n=1868)	OR	95% CI	p Value	Adjusted OR	95% CI	p Value
	n (%)	n (%)						
Area first assessed								
Emergency department	213 (85.2)	1571 (84.1)	Reference		0.077	NA		
Medical admissions unit	30 (12.0)	275 (14.7)	1.24	0.83 to 1.86				
Other	7 (2.8)	22 (1.2)	2.92	1.15 to 7.39				
Age, median years (IQR)	72.6 (62.5–83.8)	75.5 (60.6–84.3)	NA	NA	0.69	NA		
Male	134 (53.6)	953 (51.0)	1.11	0.85 to 1.44	0.443	NA		
Low severity (CURB-65, 0–1)	104 (41.6)	809 (43.3)	Reference		0.876	NA		
Moderate severity (CURB-65=2)	75 (30.0)	513 (27.5)	1.14	0.83 to 1.56				
High severity (CURB-65, 3–5)	71 (28.4)	546 (29.2)	1.01	0.73 to 1.39				
Primary outcome measures	CAP bundle (n=196*)	No-CAP bundle (n=1552*)						
CXR <4 h from admission	164 (83.7)	1314 (88.8)	0.93	0.62 to 1.39	0.717	0.93	0.62 to 1.39	0.708
Oxygen assessment	188 (95.9)	1473 (94.9)	1.26	0.60 to 2.65	0.541	1.26	0.60 to 2.65	0.544
Antibiotic <4 h from admission	146 (74.5)	1022 (65.9)	1.51	1.08 to 2.12	0.016	1.52	1.08 to 2.14	0.016
Guideline-adherent antibiotic choice	42/143† (29.4)	387/1550† (25.0)	1.25	0.86 to 1.82	0.247	–	–	–
Guideline-adherent antibiotic route	63/143† (44.1)	573/1550† (37.0)	1.34	0.95 to 1.90	0.094	–	–	–
Secondary outcome measure	CAP bundle (n=250)	No-CAP bundle (n=1862‡)						
30-day inpatient mortality	22 (8.8)	253 (13.6)	0.61	0.39 to 0.97	0.035	0.59	0.37 to 0.95	0.03

Figures in bold denote p values <0.05.

*Data in timing of antibiotic administration, timing of CXR and oxygenation assessment unavailable for 370 adults.

†Data regarding antibiotic choice and route of administration unavailable for 425 adults.

‡Data on mortality unavailable for six adults.

CAP, community-acquired pneumonia; CXR, chest X-ray; NA, not applicable.

following exclusion of all deaths was longer for the 'bundle' group (median days (IQR) 6.1 (3.1–11.4) vs 5.2 (2.4–9.5), $p=0.042$).

DISCUSSION

There was a strong response from participating sites to implement the CAP care bundle locally. Even with this determination, it took most sites over 6 months to put processes in place for bundle implementation.

Over the period of the project, the CAP bundle was delivered in a minority of all patients admitted with CAP. This was expected, given the relatively short duration of this project. Integration of a care bundle into usual working practices is a process that can take two or more years depending on the barriers to change.

Time to first antibiotic within 4 h of admission was the key process measure that was significantly better in the 'bundle' group. This measure has been shown to be associated with improved clinical outcome, and therefore, underpins the potential for the CAP care bundle to lead to clinically meaningful changes.⁴

Adjusted 30-day IP mortality was lower in the 'bundle' group. This size of effect seems unlikely to be due solely to the improvements made in the time to first antibiotic treatment. Care bundle implementation may have been associated with other quality-of-care processes, such as delivery of prophylaxis for venous thromboembolism or earlier involvement of respiratory medicine specialists that were not directly measured. Alternatively, a biased cohort of patients may have been unintentionally selected for CAP care bundle delivery; for instance, selection based on place of residence, functional status or time and day of presentation to hospital. However, the involvement of 16 separate trusts in this project makes selection bias less likely, and adds confidence to the robustness of observed improvements. In addition, our results are consistent with data from other CAP care bundle programmes that have also demonstrated reductions in mortality of similar magnitude.⁵

Overall, the results from this project are encouraging; they suggest that implementation of the BTS CAP bundle is

practically feasible, and has the potential to impact on processes of care and possibly on measurable clinical outcomes such as mortality. The recently published National Institute for Health and Care Excellence (NICE) Pneumonia Guideline reinforces the BTS CAP Guideline recommendations in relation to the elements included in the BTS CAP bundle. Further evaluation of the cost-effectiveness of the BTS CAP bundle in the light of the NICE Guideline is warranted.

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Contributors WSL drafted the manuscript, conceived and managed the project together with JMC and SW. AMT collected data, and CR analysed data. All authors reviewed the manuscript prior to submission.

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Data sharing statement The full report is accessible via the BTS: JMC, WSL, CR, AMT, SW. British Thoracic Society Pilot Care Bundle Project: a care bundles-based approach to improving standards of care in chronic obstructive pulmonary disease and community-acquired pneumonia, 2014. BTS Reports Vol 6, No 4. <https://www.brit-thoracic.org.uk/audit-and-quality-improvement/bts-care-bundles-for-cap-and-copd/>

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Supplementary Tables and Figure

Supplementary Table 1: High level data – patients admitted with CAP in participating institutions (October 2012 to October 2013)

Month	Admitted (n)	Died (n)	Mortality rate (%)
October 2012	1127	193	17.1
November 2012	1048	191	18.2
December 2012	1429	268	18.8
January 2013	1774	301	17.0
February 2013	1405	265	18.9
March 2013	1641	344	21.0
April 2013	1365	230	16.8
May 2013	1049	200	19.1
June 2013	900	190	21.1
July 2013	916	170	18.6
August 2013	708	130	18.4
September 2013	722	113	15.7
October 2013	878	142	16.2
Total	14962	2737	18.3

Supplementary Table 2: Participating trusts

Trust	No. of patients (%) Total cohort = 2563
ABM University Health Board	54(2.1)
Cent Manchester/Manchester Chlds Univ Hosp NHST	92(3.6)
George Eliot Hospital NHS Trust	159(6.2)
Gloucestershire Hospitals NHS Foundation Trust	236(9.2)
Heart of England NHS Foundation Trust	283(11.0)
James Paget University Hosps NHS Foundation Trust	155(6.0)
North Bristol NHS Trust	176(6.9)
Royal Cornwall Hospitals Trust	108(4.2)
Royal Liverpool and Broadgreen Univ Hospitals NHST	256(10.0)
St George's Healthcare NHS Trust	172(6.7)
Taunton & Somerset NHS Foundation Trust	26(1.0)
University Hospitals of Leicester NHS Trust	154(6.0)
Whittington Hospital NHS Trust	176(6.9)
Worcestershire Acute Hospitals NHS Trust	171(6.7)
Yeovil District Hospital NHS Foundation Trust	126(4.9)
York Teaching Hospitals NHS Foundation Trust	219(8.5)

Supplementary Figure 1: Proportion of CAP care bundles delivered at participating hospitals in relation to total admissions for CAP (n=14451) over the period of the project (from high level data)

